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Oxides of carbon detector

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Figure 1 - Schematic diagram of Oxides of Carbon detector

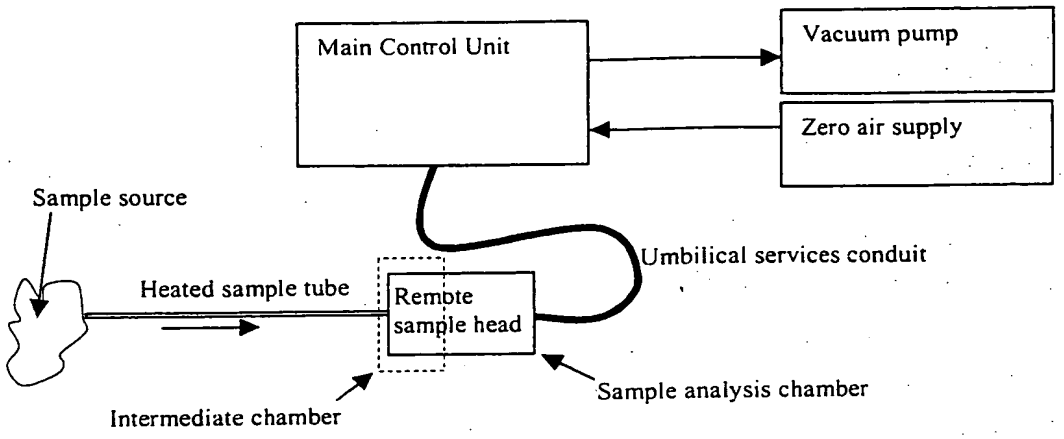
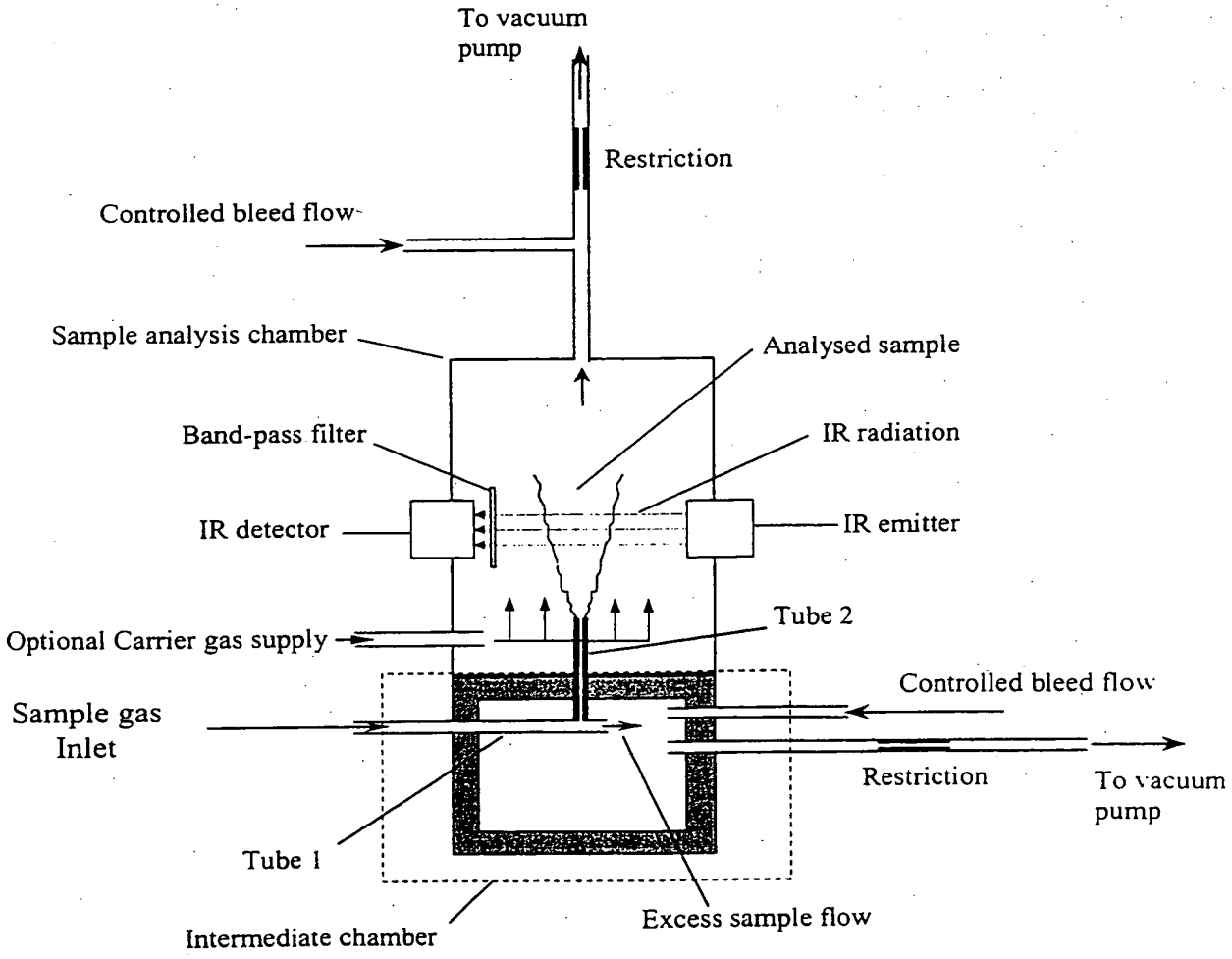


Figure 2 - Sampling system of Oxides of Carbon detector



Oxides of Carbon detector

This invention relates to an instrument for measuring the concentration of carbon monoxide and carbon dioxide in a gaseous sample.

Measurement of the concentration of carbon monoxide and carbon dioxide is carried out for a wide range of applications. Instruments for measuring carbon monoxide and carbon dioxide concentration are widely known, however, the time response for accurate resolution of concentration fluctuations in such instruments is typically of the order of seconds.

In some applications it is desirable to measure carbon monoxide or carbon dioxide concentration fluctuations on a fast time-scale. Applications include the analysis of the transient emissions from an internal combustion engine and measurements in aspirated gases from air-breathing organisms including humans.

The present invention describes the configuration of an instrument for measuring the concentration of carbon monoxide and carbon dioxide with a time response of less than 4 milliseconds.

An example will now be presented, with reference to the accompanying drawings in which:

Figure 1 shows a complete schematic diagram of an implementation of the present invention.

Figure 2 shows a diagram of the sampling system of the present invention.

The technique used here for carbon monoxide and carbon dioxide detection is a type of absorption spectroscopy. This technique is widely used in detectors of carbon monoxide and carbon dioxide concentration. Molecules that are composed of at least two different atoms absorb Infra-Red radiation by converting the light energy received into vibration/rotation energy in the molecules. IR radiation is supplied to a sample cell containing the gas using an IR emitter.
The absorption spectra of carbon monoxide and carbon dioxide are characteristic to the molecules themselves. For each molecule, very narrow ranges of wavelength (typically around 50nm) may be selected with an optical band-pass filter such that absorption within these ranges may be related predominantly to the concentration of the molecule. This absorption can be detected using a suitable IR detector.

Figure 1 shows a schematic diagram of the instrument, which consists of two main parts:

1. The Remote Sample Head. This is located close to the sample gas origin and is connected to the sample gas origin via a heated sample tube. An Intermediate chamber provides a constant sample flow from a source of varying sample pressure. Sample gas passes rapidly through the heated sample tube, the Intermediate chamber and the Sample analysis chamber. Both chambers are operated at sub-atmospheric pressure under action of a vacuum pump thereby inducing a flow from the sample source, through the heated sample tube, through the Intermediate chamber and through the Sample analysis chamber.

2. The Main Control Unit contains the electrical and fluid circuits, which control the temperatures and pressures of the sampling system, together with the circuits for the IR emitter, IR detector and signal amplifiers. It is connected to a vacuum pump and a source of pure air.

The remote sample head is connected to the main control unit by an umbilical cable of approximate length 10m.

The temperature and pressures of the remote sample head are carefully regulated to minimize drift and yield acceptable signal-to-noise ratio.

Figure 2 shows the sample system flow schematic for the Oxides of Carbon detector. The Intermediate chamber is controlled to a constant absolute pressure, which is always below the pressure at the sample gas origin. This arrangement results in a jet of sample gas being drawn into the Intermediate chamber through tube 1. The Sample analysis chamber is controlled to a constant absolute pressure which is always below the Intermediate chamber and hence a small fraction of the sample flow in tube 1 is drawn through tube 2 into the Sample analysis chamber. Tube 1 and tube 2 are arranged to be orthogonal and tube 2 forms a static pressure tapping on tube 1. The pressure difference between the Intermediate chamber and the Sample analysis chamber is very close to the pressure difference across tube 2. The mass-flow of gas through tube 2 depends upon this pressure difference.

By careful regulation of the pressures in the Intermediate chamber and the Sample analysis chamber, the sample flow into the Sample analysis chamber may be made substantially independent of pressure fluctuations at the sample gas origin.

Sample gas entering the Sample analysis chamber travels through the chamber and exits via a pipe on the opposite side. A flow of carrier gas (containing no CO or CO_2) may optionally be introduced as shown. This carrier gas may be used to prevent particulate matter in the sample from accumulating on surfaces in the Sample analysis chamber, which may cause changes to the optical measurements.

At one side of the Sample analysis chamber is an infra-red emitter and on the opposite side is an infra-red detector behind an optical band-pass filter. The specification of this filter depends upon the absorption wavelength of the gas to be detected and is different for CO and CO_2. Further pairs of IR emitters and detectors, with identical or different optical filters may be placed at alternative positions in the Sample analysis chamber for the purposes of further analysing the contents of the sample gas.

Claims

1. A **CO or CO_2 analyser** having improved response time to changes in CO or CO_2 concentration in a **source** of sample gas, said **CO or CO_2 analyser** comprising:

- A **heated sample tube** coupling the **sample source** to an **intermediate chamber** said **heated sample tube** being arranged so as to minimize the length of the path the sample gas must travel to reach said **intermediate chamber** thereby to improve the response time of said **heated sample tube**;
- An **intermediate chamber**, said **intermediate chamber** being disposed between said **heated sample tube** and a **sample analysis system** and controlled to a substantially constant static pressure less than the static pressure of said **sample source** and greater than the static pressure of said **sample analysis system** such that there is a flow of sample gas from said **sample source** into said **intermediate chamber** and from said **intermediate chamber** into said **sample analysis system**, said **intermediate chamber** containing a **tube arrangement** such that a portion of the flow of sample gas from said **sample source** entering said **intermediate chamber** is drawn into said **sample analysis system** and such that the flow of sample gas from said **intermediate chamber** into said **sample analysis system** is orthogonal to the axis of the flow from said **sample source** into said **intermediate chamber** thereby to make the static pressure of the sample flow at the entry of the tube from said **intermediate chamber** into said **sample analysis system** (said entry being located in said **intermediate chamber**) substantially constant and approximately equal to the static pressure of said **intermediate chamber** and thereby to make the flow of sample gas from said **intermediate chamber** into said **sample analysis system** substantially constant and independent of static pressure fluctuations at said **sample source**, said **tube arrangement** being designed to minimize the length of the path the sample gas must travel to reach said **sample analysis chamber** thereby to improve the response time of said **CO or CO_2 analyser**;
- A **sample analysis system**, said **sample analysis system** being disposed immediately adjacent to said **intermediate chamber** and controlled to a constant static pressure below the static pressure of said **intermediate chamber**, said **sample analysis system** comprising a **chamber** through which the sample passes containing one or more pairs of **infra-red emitters and detectors**, with or without optical filters said **infra-red emitters and detectors** being arranged with optical paths crossing the sample flow, said **sample analysis system** being designed so as to minimise the residence time of sample gas in said **sample analysis system** thereby to improve the response time of said **CO or CO_2 analyser**;